## Space Weather Technical Forecast

Issued on Friday 7 February 2025 at 13:03 Local

**This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: R1/R2 expected, chance of R3. Chance of S1. G1 likely Day 3 (09 Feb).**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Moderate with four M-flares, the largest being M7.5 at 07/0921 UTC, from the cluster in the northwest.

There are now ten active regions on the Earth-facing disc. The majority of interest is in the northwest quadrant, with a cluster of entwined regions containing AR3976, AR3977, AR3978, AR3981 and AR3984. Of these, AR3981 remains the largest and most complex region on the visible disc, with three strong delta regions and recent development of the intermediate spots. The other regions within this cluster are close together and it is difficult to define the exact boundaries of each region. As such they are magnetically interconnected, with interaction between the various regions. The remaining regions on the disc are small and simple at the present time.

A faint CME is visible in some coronagraph imagery from the M7.5 flare. This is still under analysis, but an Earth directed component is possible.

**Solar Wind / Geomagnetic Activity:** Solar winds, as measured by ACE and DSCOVR at L1, showed a coronal hole fast wind type signature, perhaps with some limited CME influence. Wind speeds were initially elevated near 500 km/s, declining gradually to slightly elevated levels around 400 km/s. The density was mostly average or below. The Interplanetary Magnetic Field was weak to moderate, with peaks of 8nT. The north-south component, Bz, varied between +6/-4nT but was predominantly northward directed. The phi angle was positive (away from the Sun) throughout. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

**Energetic Particles / Solar Radiation:** High energy proton flux at GOES18 remained at background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at mostly background levels. The associated 24-hour fluence persisted below the Active threshold on a declining trend, recording 3.14e6 integrated pfu at 07/0000UTC.

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# Space Weather Technical Forecast

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Moderate activity is expected to continue, with a chance of an X-class flare, primarily from the cluster of regions in the northwest.

**Solar Wind / Geomagnetic Activity:** Two CMEs have a low chance of giving some influence at Earth, the first late Day 1 into Day 2 (07-08 Feb) and the other late on Day 4 (10 Feb). Both are low confidence. A further CME may have emerged following the recent M-flares from the NW on 07 Feb, but this is still under analysis. The fast wind from CH13/- is expected to arrive during Day 3 (09 Feb), perhaps more likely during the second half of the day, potentially bringing speeds of 500-600 km/s

Predominantly Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected, with a slight chance of Active to G1/Minor Storm intervals if we do see any CME influence late Day 1 into Day 2. Activity is then expected to increase again during Days 3-4 due to the fast wind from CH13, perhaps with some limited CME influence, becoming Unsettled to G1/Minor storm (Kp 3-5) with a slight chance of G2/Moderate storm intervals.

**Energetic Particles / Solar Radiation:** There is a chance of S1/Minor radiation storm events , as the cluster of sunspots in the northwest are now in a good position to connect with Earth, should there be further large flares.

High energy electron flux observed at GOES16 is be mostly at background levels, perhaps with a rising trend on Day 4 (10 Feb). The corresponding 24 hour fluence is expected to persist below the Active threshold.

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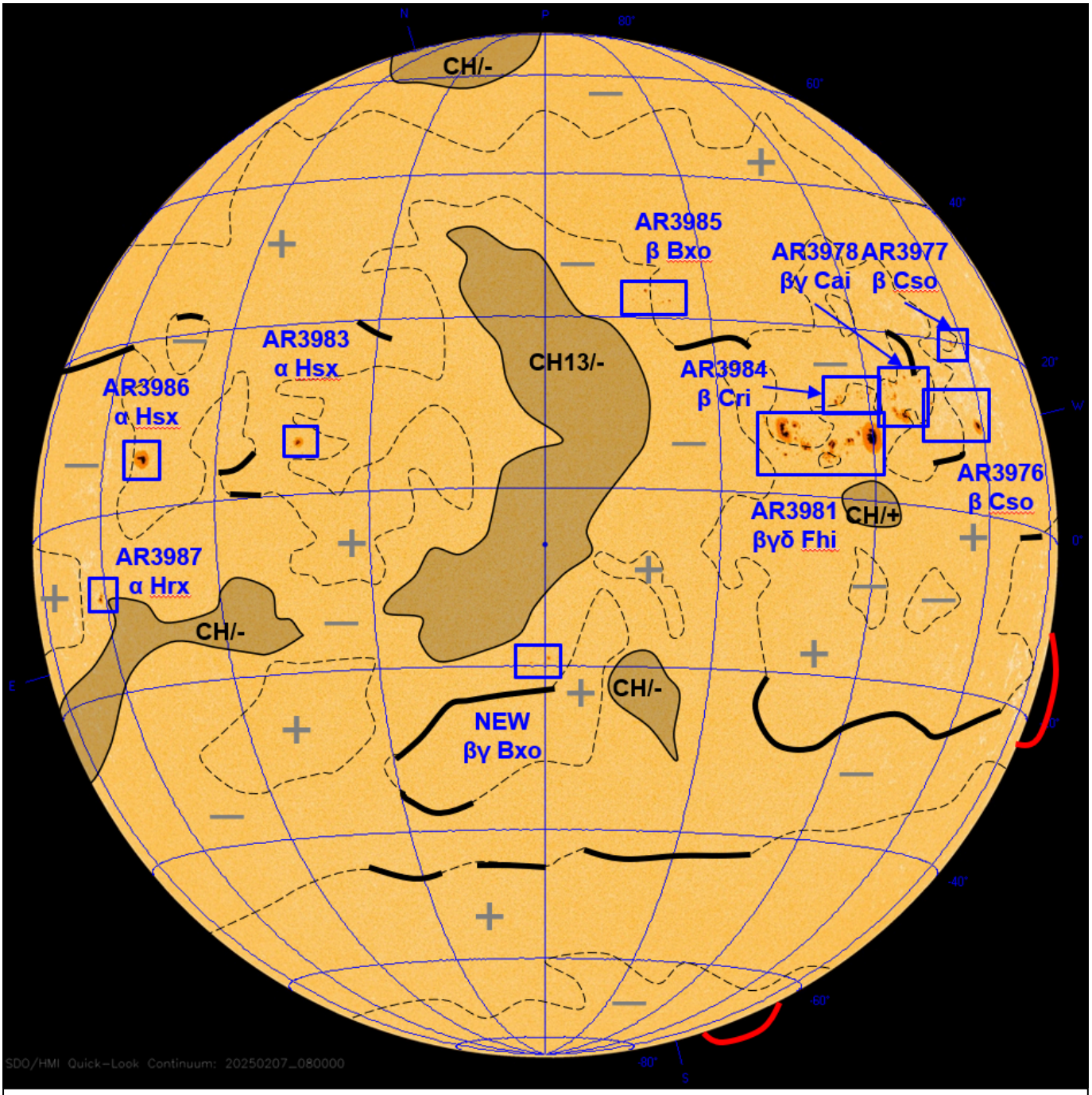
**Figure 1: Solar synoptic map valid 07/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms

A CME from a filament eruption in the southwest, from early on 05 February, has a low chance of delivering a glancing blow late Day 1 into Day 2 (07-08 Feb). Another CME associated with the M7.6 flare from AR3981 on the 6th, may arrive late on Day 4 (10 Feb). A further CME may have emerged following the recent M-flares from the complex of spots in the NW on 07 Feb, but this is still under analysis.

The next recurrent feature, the High Speed Stream from CH13/-, is expected to arrive during Day 3 (09 Feb), perhaps more likely during the second half of the day. This feature appears to be larger and more intense compared to the previous rotation, when speeds reached around 450 km/s. On this rotation solar winds are expected to become elevated to potentially strong at 500-600 km/s, in line with MOSWOC Enlil expectations. However, Enlil may be too early for the HSS arrival at Earth.

Predominantly Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected, with a slight chance of Active to G1/Minor Storm intervals if we do see any CME influence late Day 1 into Day 2. Activity is then expected to increase again during Days 3-4 due to the HSS from CH13, perhaps with some limited CME influence, becoming Unsettled to G1/Minor storm (Kp 3-5) with a slight chance of G2/Moderate storm intervals.

| Geomagnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 10 | 10 | 60 | 50 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

### Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R⊙ (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed (km/s) | Estimated Arrival Time (UTC) | Comments |
|---|---|---|---|---|---|---|
| 05/0645 | Partial | Filament | SW | 790 | 08/0000 +/- 6 hours | Low chance of glancing impact. |
| 07/0200 | Partial | AR3981 | NW | 300 | 10/2100 +/-12 hours | Low confidence. |

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**Figure 2: MOSWOC Enlil, showing the onset of the HSS on 08 Feb, which is likely a bit too early.**

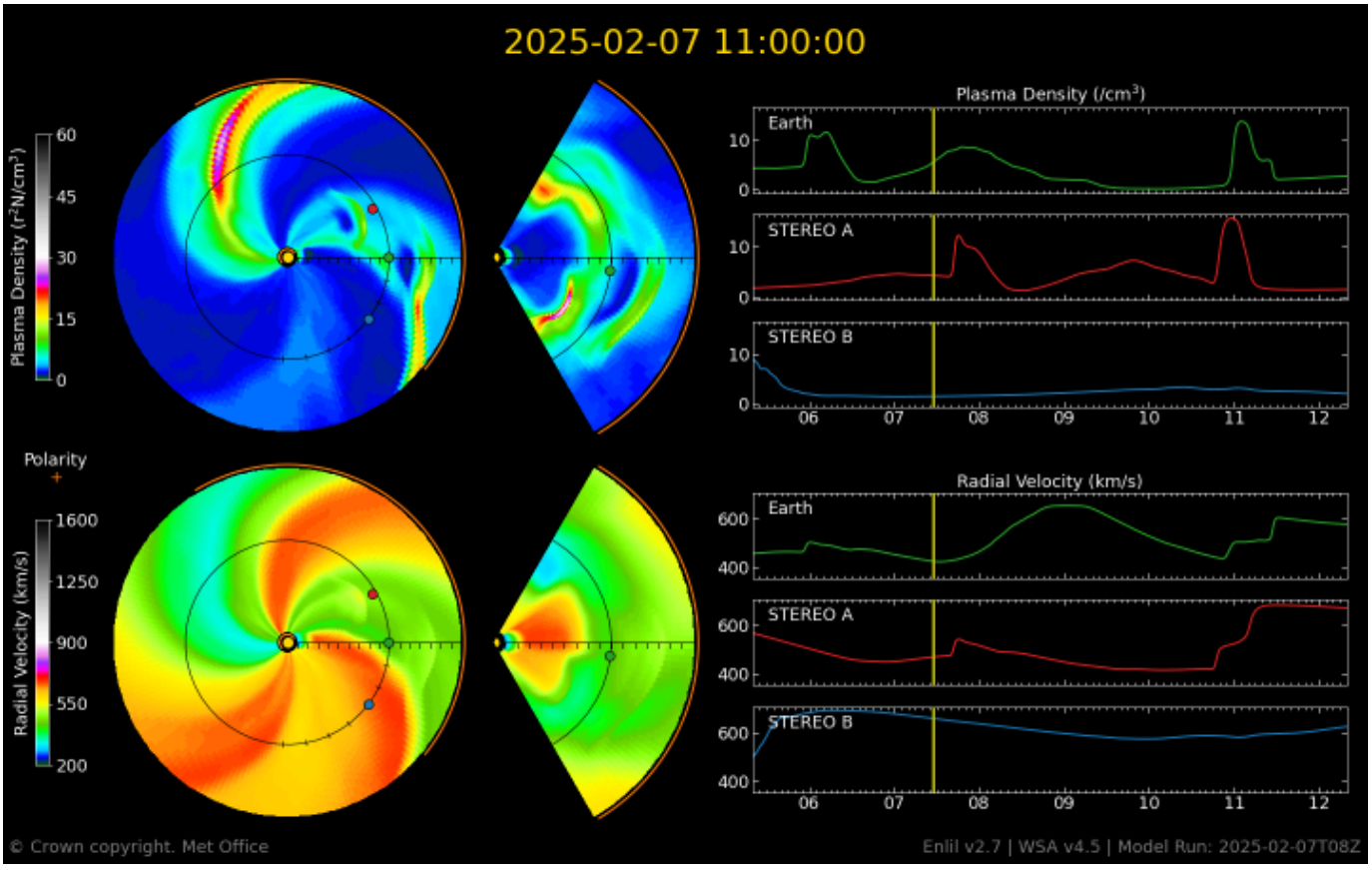




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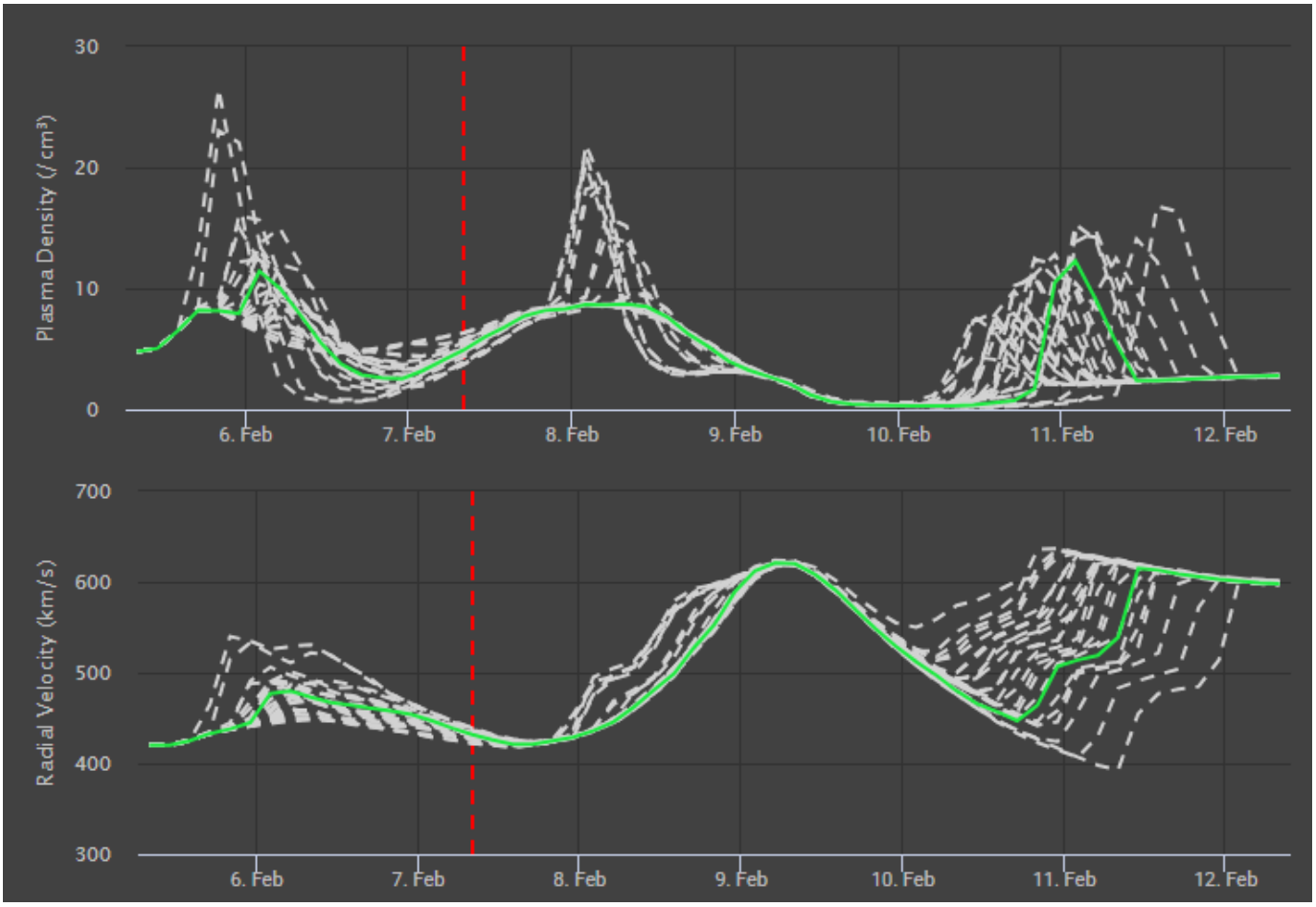
**Figure 3: Enlil ensemble, showing two potential CME glances over the next few days.**



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## Radio Blackouts - X-Ray Flares

There are now ten active regions on the Earth-facing disc, with a new region developing near south centre disc. The majority of interest is in the northwest quadrant, with a cluster of entwined regions containing AR3976, AR3977, AR3978, AR3981 and AR3984. Of these, AR3981 remains the largest and most complex region on the visible disc, with two strong delta regions and recent development of the intermediate spots. The other regions within this cluster are close together and it is difficult to define the exact boundaries of each region. As such they are magnetically interconnected, with interaction between the various regions. The remaining regions on the disc are small and simple at the present time.

The leading edge of the northwestern cluster will start to leave the disc during Day 4 (10 Feb), but influence is unlikely to decline until after the end of this period. Recurrence suggests the potential for one or two returning regions, but until these groups can be seen and assessed it is difficult to classify the likely activity level.

Solar activity has been Moderate with four M-flares, the largest being M7.5 at 07/0921 UTC, from the cluster in the northwest. Further M-flares are expected, with a chance of an X-class flare.

| X-Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 (M Class) | Yes | 80 | 80 | 80 | 80 |
| Very Active | R3-R5 (X Class) | No | 25 | 25 | 25 | 25 |

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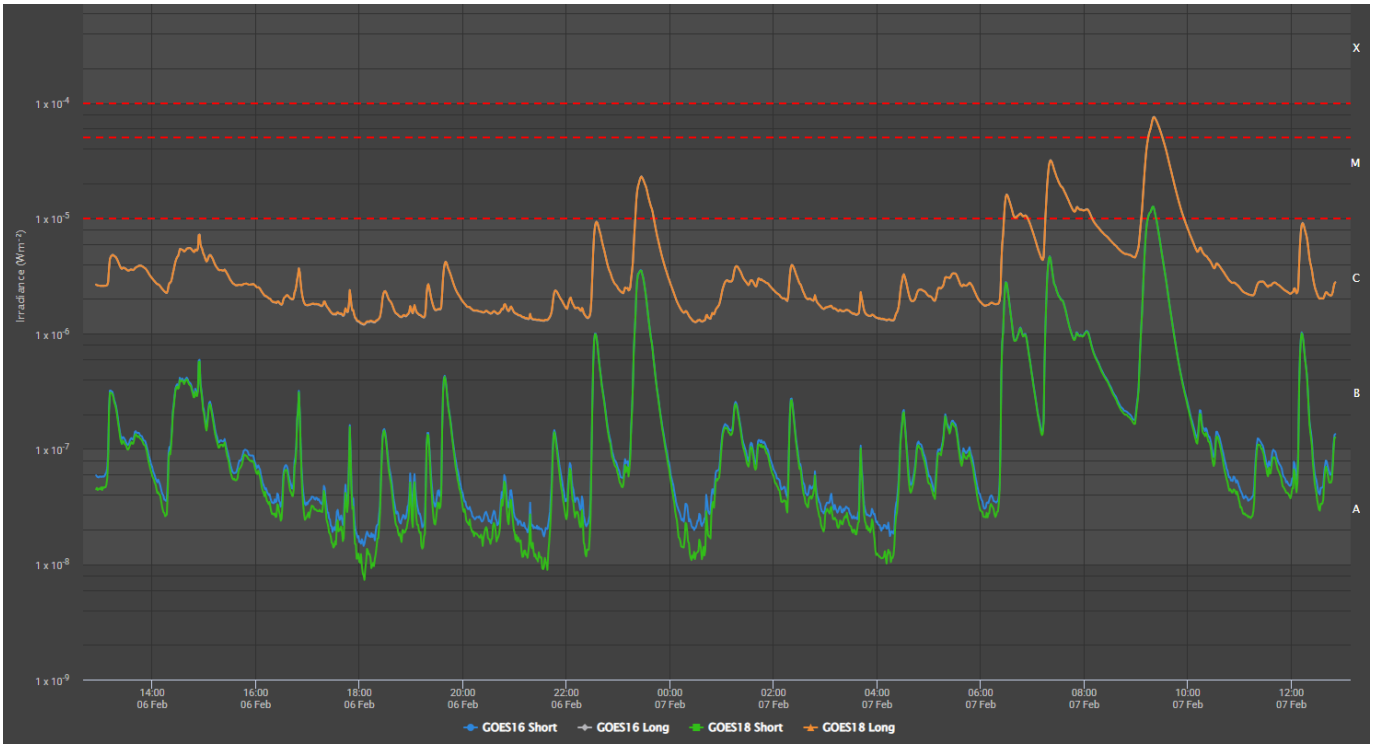
**Figure 4: X-ray flux at GOES16 and 18, showing four M-flares in the last 24 hours.**



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## Solar Radiation Storms (High Energy Protons)

The northwestern cluster of sunspots, including AR3981, is now in a good position to connect with Earth and produce an increase in proton flux after any large flares. That said, the two recent R2 events have not produced any proton response so far. Overall, there is a chance of reaching above the S1/Minor radiation storm threshold throughout the period.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}sr^{-1}s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 25 | 25 | 25 | 25 |
| **Very Active** | **≥ S3 *** | No | 5 | 5 | 5 | 5 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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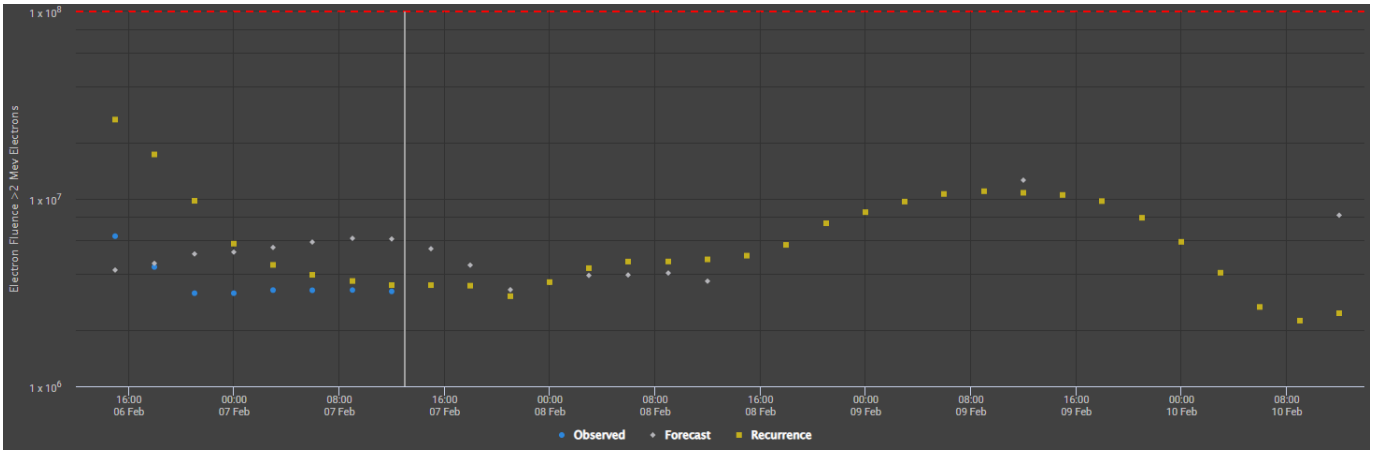
## High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at mostly background levels. The next likely charging mechanism for the Van Allen belts is CH13/-, but any subsequent significant rise in electron levels is expected to be beyond the current forecast period. Possible CME arrivals in the interim complicate this picture somewhat, but overall mostly background electron flux is expected until perhaps later on Day 4 (10 Feb).

The corresponding 24-hour fluence is expected to persist below the Active threshold through this period, perhaps with a rising trend later on Day 4. MOSWOC REFM output shows levels well below Active through the next 72 hours, however this will not account for intervening CMEs nor the increased intensity of CH13/-.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1\times10^{8}$** | No | 1 | 1 | 1 | 5 |
| **Very Active** | **≥ 2 MeV ≥ $1\times10^{9}$** | No | 1 | 1 | 1 | 1 |

**Figure 5: MOSWOC REFM, showing a below Active forecast for the next three days. REFM will not be taking into account the strength of the upcoming HSS and any CME influence, however.**

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